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ANATOMY OF PALUDICELLA ARTICULATA.

PROCEEDINGS

OF

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REV. JAMES H. TODD, D. D., Vice-President, in the Chair.

Mr. G. J. Allman, read the following paper on the Muscular System of certain fresh water ascidian Zoophytes, being the first of a series of memoirs which he proposed presenting to the Academy on the physiological and zoological history of the zoophytes of fresh water.

"The subject on which I have now the honour of addressing the Academy, belongs to a hitherto but little investigated department of zoology, the structure of the ascidian zoophytes* of fresh water. Our present knowledge of these minute creatures is chiefly due to Raspail, the distinguished French naturalist and chemist, whose researches into the structure of Alcyonella Stagnorum, are characterized by much patient observation,† while in these countries the subject has been totally neglected. Not so, however, with the ascidian zoophytes of the ocean; these interesting animals have had both here and on the continent some able investigators, among whom none deserve to be mentioned before

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* The zoophyta ascidioida of Johnston are synonymous with the bryozoa of Ehrenberg, and the ciliobrachiata of Farre, and include all those zoophytes whose organization is referrible to the molluscan type.

† Compte rendu des seances de l'Academie des Sciences. 4 Fevrier, 1839.

Milne Edwards, and Farre, and it is especially to the latter indefatigable and accurate observer that we are indebted for a knowledge of the minute anatomy of these most curious and highly organized polypes. Though in my own investigations into the anatomy of the fresh water zoophytes of this order, I have not restricted myself to any particular structures, I yet intend, in the following remarks, confining my observations to their muscular system; reserving for some other occasion the pleasure of directing the attention of the Academy to those points of their anatomy not dwelt upon in the present paper.

"In the remarks which I am about to offer, it will be seen how closely the ascidian zoophytes of our fresh waters correspond in organization with the marine species; and though in minute anatomical detail certain differences will be observed, yet these differences are far from invalidating the unity of the type of structure,—a unity which will be found from the following observations to pervade, in a remarkable degree, the entire order. I would wish it to be understood too, that if I should in any respect differ from the statements of Dr. Farre, I offer no opposition whatever to his observed facts, but solely to one or two of the conclusions to which they have induced him to arrive.

"The animal of the present order, to the muscular anatomy of which I have chiefly attended, is one which has not as yet been recorded as a native of the British Islands. About two years since I was sent, by Mr. William Thompson of Belfast, to whose researches into the natural history of this country we are so much indebted, a small portion of the dried polypidom of a zoophyte, which he found, in September, 1837, cast upon the shore of Lough Erne. From the dried condition of the fragment,—a condition in which the fresh water zoophytes lose all their most interesting characters,—I was unable at the time to arrive at anything satisfactory in the investigation of the species; I therefore contented myself by sketching in my note-book, the few imperfect external characters which continued visible on the dry and shrivelled zoophyte. No farther than this did my knowledge of Mr. Thompson's discovery extend, when an opportunity fortunately occurred in October last, of obtaining living specimens of the animal. These I discovered in the Grand Canal, near Dublin, and have thus been enabled to pursue my investigations, from which I find the species to be one of great interest. I find, moreover, that although it has been hitherto unnoticed, as a British animal, it is identical with the alcyonella articulata of Ehrenberg, for which Gervais, who found the animal near Paris, subsequently constituted a new genus, under the name of Paludicella.* It is also noticed by Van Beneden, who met with it near Louvain, and gives a figure of it,† which, though not very good, will yet be found of use in the identification of the species. Though Ehrenberg's appellation possesses the claim of priority, yet, as it refers the zoophyte to a genus into which its structure will not admit it, it must be rejected, and I shall accordingly adopt the name Palludicella, by which it has been designated by Gervais.

"In the following remarks upon the muscular system of the fresh water ascidian zoophytes, my description of this system is chiefly derived from observations made upon Paludicella articulata, as there are certain points in the muscular anatomy of other species, upon which I cannot as yet speak with certainty, and for completing my observations on which, I must wait until the approaching Spring shall afford me fresh objects for investigation.

"In describing the muscles of these animals, I have availed myself of Dr. Farre's phraseology, applying to the several sets of muscles in the fresh water ciliobrachiate zoophytes, the same terms which Farre has given to the analogous sets in the ciliobrachiates of the sea.

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* Bulletin de l'Acad. Roy. de Bruxelles, an. 1839.

† Mem. de la Société d'Hist. Nat. de Paris, tom. 4.

" In Paludicella then, three groups of muscles may be detected. These are strictly analogous to muscles which have been demonstrated in the salt water zoophytes of the same order, and for a description of which, we are indebted to an admirable paper of Dr. Farre, in the Philosophical Transactions, an. 1837. The first of these groups to which I shall direct your attention, corresponds with the anterior set of retractor muscles of Farre. It may be observed (fig. 3 and 4, *h, h*) to take its origin from the internal surface of the walls of the cell near the middle, and thence to pass upwards in order to be inserted into the margin of the tentacular disk, and upper part of the pharynx. The action of this group is obvious, it is the true retractor apparatus of the polype, and it is worthy of remark, that neither in this nor in any other fresh water zoophyte whose anatomy I have studied, could I detect muscular fibres analogous to those described by Farre, as inserted into the remote extremity of the stomach in those zoophytes of the sea which had come under his observation.

" The second set of muscles to be described in Paludicella, consists of four bundles of fibres (fig. 3 and 4, *i, i, i*) which arise from the inner walls of the cell near the top, two at each side, having the tubular orifice between them. From this origin, they pass towards the aperture of the cell, slightly converging, and are inserted by distinct attachments, which are all placed in the same plane, into the inner surface of the tube near the margin of the orifice. These are in every respect analogous to the muscles which Farre describes under the name of opercular, and to which he ascribes the office of assisting in the inversion of the polype tube drawing in its margin after the retreating polype, and by their continued action, closing the orifice of the cell. Reasons will presently be given for dissenting from this view of the action of the opercular muscles, and in the meantime I shall proceed to the description of the third group.

"The third group is analogous to one detected by Dr. Farre, in the ascidian zoophytes of the sea, and to which he has given the name parietal. The parietal muscles take a transverse course, and originate and terminate in the internal membrane of the cell. In paludicella (fig. 3 and 4, *k, k, k, k*) they are rather numerous, and consist of short fibres of variable length, which pass transversely round the internal tunic, being capable of detection through nearly the entire length of the cell, and sometimes passing one another in their course, they may be seen to surround the cell with a contractile tissue. Dr. Farre is of opinion, that these muscles in the zoophytes which he has examined, are attached by their extremities only, being free in the intermediate space. In paludicella however, I saw nothing which would lead me to suspect, that in this zoophyte such was their disposition. I shall not here, however, speak positively, as it will require more extensive observations before any decisive conclusion can be arrived at.

" Such are the three great groups of muscles which I have succeeded in detecting in paludicella, and so far as my observations have gone, analogous groups are to be found in the other fresh water ciliobrachiates. It will at once be seen, by any one acquainted with Dr. Farre's paper, that while the muscles just described correspond in all their important features with those of the ascidian zoophytes of the sea, thus beautifully demonstrating the unity of type by which the order is characterized, yet in the details of the several groups, some remarkable modifications will be found to exist.

"The first thing which strikes us is the absence, probably among all the fresh water ascidian zoophytes of that well-developed fasciculus of muscular fibres, which is observed in those of the sea, to arise from the bottom of the cell, and pass upwards to be inserted into the fundus of the stomach. It is true, that Trembley describes in alcyonella stagnorum, a certain appendage to the fundus of the stomach, to which he assigns the office of a retractor muscle; " J'ai vu," says Trembley, " distinctement, lorsque les polypes à panache etaient bien au dehors de leur cellules un fil qui tenait d'un côté a l'extrémité inferieure de l'estomac et de l'autre au fond de la cellule."* Raspail supposes this an erroneous observation, and conceives that Trembley mistook for a distinct organ, the appearance presented under the microscope, by a fold of the reflected tunic.† Notwithstanding, however, the criticism of Raspail, I believe the observation of the celebrated historian of the green polype to he perfectly correct, though his reasoning is erroneous.

" I have myself witnessed in Plumatella repens, an organ in every respect corresponding to Trembley's description; I believe this organ to be an ovary, though from its position and attachments, Trembley's opinion might at first appear correct, and the structure in question might be supposed analogous to the posterior set of retractor muscles in the ciliobrachiate zoophytes of the sea. This supposition, however, is untenable, and I have satisfied myself by repeated observations, that no such function is performed by it; it is observed to undergo no contraction, and its motions are entirely passive and dependant on those of the body of the polype.

" In the same animal, Trembley also describes as retractor muscles, filaments attached by one extremity to the base of the plume of tentacula, and by the other to the bottom of the cell;‡ but this, likewise, is considered by Raspail as an error, and referrible to the same source as the former. Here again I must dissent from the French naturalist; the filaments alluded to by Trembley correspond closely with fasciculi described above, as existing in paludicella, and which I have also witnessed in other fresh water zoophytes; and I cannot but think, notwithstanding the high authority of Raspail, that they are really such as Trembley describes them. It is worth remarking, that Raspail denies the existence of retractor muscles in alcyonella, believing that, with the general contractility of the animal, such a contrivance would be superfluous. I have not yet succeeded in obtaining any specimens of alcyonella, so that upon this point I cannot speak from direct observation. Since these muscles, however, are particularly well marked in all the fresh water ascidian zoophytes, whose anatomy I have studied, as well as in those of the ocean, I must still adhere to the original observation of Trembley; for it can hardly be supposed, that a genus so nearly allied to those in which the system in question is well developed, and which Raspail, by the way, would consider but as a different grade of evolution, should be altogether destitute of them.

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* Hist. des Polypes d'Eau douce, p. 216.

† Mem. de la Soc. d'Hist. Nat. de Paris, tom. 4, p. 92.

‡ Op. cit. p. 216.

" In Plumatella repens I have examined, with much care, the retractor apparatus. In this species it consists of two fasciculi of muscular fibres, which arise from the sides of the cell near the bottom; and thence passing upwards symmetrically, one along each side of the body of the polype, receive an extensive attachment, being inserted into the wide part of the tentacular crescent, into the pharynx for its entire length, and into the upper part of the stomach; a few fibres appear detached at each side from the main fasciculus, to be inserted more externally near the base of the tentacular lobes. The function of these muscles is evident, acting from their more fixed attachment to the side of the cell, they become powerful retractors, by which the body of the polype is drawn inwards and concealed in the more internal parts of the polypidom.

" In the opercular muscles, paludicella offers no remarkable deviation from the general arrangement of these muscles in the salt water species. In plumatella repens, however, and perhaps in most other species of fresh-water ciliobrachiates, their arrangement is very peculiar. In this zoophyte, they consist of a series of about twenty-five distinct delicate fasciculi, which arise from the internal surface of the cell at regular intervals, and in a plane perpendicular to its axis, and thence radiating inwards are inserted into the opposed surface of the reflected tunic.

" In assigning their proper office to the muscles which have been already described as the true retractor apparatus of the polype, no difficulty whatever is met with; neither can we be at a loss in discovering the true function of the parietal muscles, for these acting upon the flexible internal tunic of the polype cell, must necessarily, by their contraction, diminish transversely the space included between this tunic and the body of the polype, a function the great importance of which, in the economy of the little animal, will presently be apparent. When, however, we attempt to explain the action of the opercular muscles, the task will perhaps be found not quite so easy. It has been stated that Dr. Farre assigns to these muscles the office of drawing in the flexible portion of the polype tube after the retreating polype, and by their continued action closing the orifice of the cell. I cannot help thinking, however, that in ascribing this office to the opercular muscles, Dr. Farre is correct but to a very limited extent, and that their chief use is directly opposite to that assigned to them by this excellent observer. The use which I would assign to the opercular muscles is, first, that of assisting the polype in its protrusion, an office which they accomplish by fixing and preserving in the axis of the polype tube that portion of the reflected tunic (fig. 4, *c*, *c*) which is included, during the retracted state of the animal, between the summit of the fasciculus of approximated tentacula, and the orifice of the cell; and, secondly, what is a still more important function, that of affording to the respiratory surface, when the polype is retracted within the recesses of its cell, a constant supply of fresh water, of which the little animal would be deprived, were it not that some means existed of dilating the tubular reflection of the tunic, an office to the performance of which these muscles are fully adequate, acting then in a state of antagonism to the parietal muscles, which tend to keep the orifice of the tube closely shut.

" My objections to Dr. Farre's view of the function performed by the muscles in question are referrible to three heads: first, want of necessity in ascribing to them the office for which this anatomist believes them destined; secondly, their inability to perform the function which he ascribes to them; and thirdly, the possibility of assigning to them another office in full accordance with the necessities of the animal.

" That we are not obliged to seek for opercular muscles, in order to account for the closing of the orifice when the polype has retired into the recesses of its cell, is evident, if we give the slightest consideration to the action of the true retractor muscles. It is quite plain that the retraction of the polype itself, which is effected by the muscles which act directly upon it, is amply sufficient to produce the complete invagination of the flexible termination of the cell; and, accordingly, observation will convince us that this invagination follows exactly the retraction of the polype, and is evidently related to the latter action as an effect to a cause. That the opercular muscles cannot, except in a very partial manner, produce the effect ascribed to them by Dr. Farre, is also evident, when we reflect upon their course and attachments. Arising from the circumferential portion of the cell, and thence passing inwards, to be inserted into a point nearer to the axis, they must, after the invagination of the tunic has proceeded beyond the plane of their insertion, possess upon the reflected tunic a decidedly *dilatable* action,—an action which is antagonized, first, by the parietal muscles, as will be presently explained, and, secondly, by the true retractor muscles; for these muscles, acting through the medium of the polype, in most instances nearly centrally, or in the axis of the tube, will not, in their ordinary action, possess any dilating power, but, on the contrary, will tend to close the aperture by approximating the sides of the tubular reflection of the cell.

" Since we have thus seen that the opercular muscles are incapable of producing the closure of the orifice, it becomes an interesting subject of inquiry to determine by what means the act in question is performed, and indeed a slight consideration will render manifest the simple yet effective mechanism appropriated to this purpose. The great agents by which the closure of the cell is effected are to be found in the parietal muscles, for these fibres, by pressing the fluid of the cell against the tube of invaginated membrane (fig. 4, *c*, *c*), will approximate the sides of this tube to one another, at the same time that the membrane will be thrown upwards against the aperture of the cell, thus completely closing the orifice, and enabling the little animal to rest secure from all intrusion in the recesses of the polypidom.

" After this account of the muscular system of the polypes, the mechanism will now be easily understood by which the animal is protruded from its cell when hunger calls it forth to seek its food in the surrounding medium, or when desirous of exposing its respiratory surface still more perfectly to the vivifying influence of the aerated water.

" Previously to the discovery of the parietal muscles no satisfactory explanation had been given of the protrusive act of the polype, and even since the detection of these muscles by Dr. Farre, their share in effecting the protrusion of the animal would appear to be underrated. Dr. Farre considers their influence in this respect as of secondary importance, and would seem to attribute the act in question mainly to the straightening of the œsophagus, which in the ciliobrachiates of the sea is bent upon itself during the retracted state of the polype. In none of the fresh water species, however, which I have examined, with the exception of Paludicella articulata, does this curvature of the œsophagus appear to exist; we therefore cannot in these instances have recourse to its agency in accounting for the phenomenon now under consideration, and we are consequently driven to the parietal muscles, or to the general contractibility of the internal tunic, as the only provision by which this important act can be effected. I mention the general contractibility of the internal tunic as a probable agent in protrusion, for I do not think the existence of the parietal muscles throughout the entire order as yet sufficiently established.

" We shall now suppose the polype withdrawn into the recesses of its cell, and that hunger or some other stimulus impresses on it a desire of protrusion. The parietal muscles, which appear to me to be the direct agents in effecting the protrusive act, now begin to contract, and thus exercise a pressure on the fluid which surrounds the polype, and is included between the latter and the internal membrane of the cell. The compressed fluid in its turn acts upon the polype, and by its upward pressure against that portion of the flexible tunic which is carried in by the animal during its retreat, will tend to produce an eversion of this membrane, which, in the completely retracted state, constitutes a tube of some length between the summit of the fasciculus of approximated tentacula and the orifice of the cell. The opercular muscles at the same time coming into play will, by their nicely adjusted action, keep the invaginated tunic exactly in the axis of the orifice, and thus materially assist in effecting the necessary protrusion, which, by the continued action of the parietal muscles, will go on increasing till the complete evagination of the reflected membrane has taken place. This, then, I conceive to be the true account of the protrusive act, and that the apparatus just mentioned is amply sufficient for the purpose, without having recourse to the agency of the bent œsophagus,—an agency which in plumatella repens, and other fresh water zoophytes, which I have examined, assuredly does not exist, as in these the œsophagus is straight during the retracted state of the animal. In the remarks now offered, however, I do not deny that some influence is exercised by the straightening of the œsophagus in those species in which this tube is bent upon itself previously to the commencement of protrusion; I merely wish to assert that we are not necessarily obliged to have recourse to this agency, but that in some instances, at least, the parietal muscles, or, in their absence, the general contractility of the internal tunic, are agents perfectly effective.

" Such are the observations which I have had an opportunity of making on the muscular system of the ascidian polypes of fresh water. I am fully aware that they are far from being perfect, but for this my excuse must be found in the extreme difficulty of such investigations, made, as they all necessarily are, under a high power of the microscope, with an illumination most carefully adjusted, and which can by no means be at all times obtained, in order that structures of such extreme tenuity and transparency may not entirely escape detection. The observations have all been made on the living animals, and no one who has not devoted himself to such investigations can form any idea of the close and patient attention which they require,—the constant watching to obtain the animal in the exact condition or position, in which alone certain peculiarities of structure are apparent; and, finally, the mortification of finding the conclusions to which we had arrived on one day, after hours of painful attention, invalidated by some more favourable observation on the next.

" In the present communication I have confined myself to the muscular system; on some other occasion I may perhaps again entreat the indulgence of the Academy, while I lay before it my observations upon other not less interesting parts of the structure of these curious animals."*

DESCRIPTION OF THE PLATE.

Fig. 1. Paludicella articulata; natural size.
Fig. 2. Portion of the polypidome magnified.
Fig. 3. A cell with the polype exserted.

a, *a*, *a*. The polype cell.

b. The orifice of the cell.

c. That portion of the internal tunic which is carried out by the polype during its egress from the cell.

d. The stomach of the polype.

e. The rectum.

f. The œsophagus.

g. The crown of tentacula exserted and expanded.

h, *h*. The proper retractor muscles of the polype; they are now relaxed, and carried out by the animal in the act of protrusion.

i, *i*. Two of the four sets of opercular muscles, also in a state of relaxation.

k, *k*, *k*, *k*. The parietal muscles, preserving, by their contraction, the membrane *c*, in a state of tension, and thus maintaining the exserted condition of the polype.

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* After the present account had been written, I happened to meet with a paper by M. Dumortier, in the Bul. Ac. Brx. an. 1835, on the *Polype à Panache* of Trembley, a polype belonging to the order now under consideration, and for which M. Dumortier constitutes a distinct genus under the name *Lophopus*, characterized by the tentacula, being destitute of cilia. So remarkable an exception, however, would this character offer to that of the entire order, that I cannot but suppose Dumortier in error; an opinion in which I believe myself fully born out by the phænomena subsequently described by this naturalist, and which are evidently the result of imperfectly observed cilia.

Dumortier details, at considerable length, the anatomy of the zoophyte, and has witnessed fibres corresponding with the retractor and opercular muscles described in the present communication. His paper is well worth perusal, though some of his statements will require further corroboration.

Fig. 4. A cell with the polype retracted.

a, *a*, *a*. The polype cell.

b. The orifice of the cell.

c, *c*. The inverted membrane, which, in the completely retracted condition of the polype, consists of that portion of the internal membrane which had been carried out in the act of exsertion, together with the more flexible termination of the external tunic of the cell.

d. The stomach of the polype.

e. The rectum.

f. The œsophagus. Both rectum and œsophagus are here curved upon themselves, and thus accommodated to the retracted state of the polype.

g, *g*. The crown of tentacula retracted, and the tentacula approximated into a close fasciculus.

h, *h*. The proper retractor muscles of the polype in a state of contraction.

i, *i*, *i*. The opercular muscles also contracted.

k, *k*, *k*, *k*. The parietal muscles relaxed.

Dr. Robinson gave a brief account of meteors observed at Armagh on the 10th of August, 1842, apologizing for the imperfect nature of the observations, while he felt that it was desirable that they should be placed on record.

The sky had been overcast, but became clear a little after ten, of which Dr. R. was availing himself to try an eyepiece of a peculiar construction, when the appearance of two large meteors, travelling in nearly the same direction, reminded him of the peculiar character of the 10th, and in conjunction with T. F. Bergin, Esq. and another observer, he proposed to watch for others. The roof of the dwelling-house afforded an excellent position. Mr. Bergin looked south-west; he (Dr. R.) east; and the third north. From $10^{h}.55^{m}$. Armagh time, till 12^{h}, seventy-eight were seen; of which about twenty were in Dr. Robinson's district, and fifty in Mr. Bergin's. With scarcely any exception, their ten-